INDOOR AIR QUALITY ASSESSMENT

Elizabeth Pole Elementary School
110 County Street
Taunton, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Center for Environmental Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program

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Background/Introduction

At the request of Donald Clearly, Superintendent, Taunton Public Schools, The Taunton Board of Health (TBOH), teachers and parents, the Massachusetts Department of Public Health's (MDPH) Center for Environmental Health (CEH) provided assistance and consultation regarding indoor air quality at the Pole Elementary School (PES), 110 County Street, Taunton, Massachusetts. The request was prompted by concerns about mold growth and chronic problems with water penetration in the building.

On January 20, 2005, Cory Holmes, an Environmental Analyst in CEH's Emergency Response/Indoor Air Quality (ER/IAQ) Program, conducted a preliminary walkthrough of the PES. Mr. Holmes returned on February 3, 2005 to conduct an indoor air quality assessment. Mr. Holmes was accompanied for portions of the assessment by W. Gerard Sanborn, Director of Operations, Taunton School Department (TSD); Kevin Sweet, Sanitary Inspector, TBOH; Stephanie Zerchykov, Principal, PES; and Denise Dukeman, teachers' representative.

The PES is a single-story, concrete block building constructed in the 1960s. TSD officials reported that some improvements to the building have been made over the years, including several roof replacements, replacement of thermostats and other pneumatic controls to the heating-ventilation system and some minor interior renovations. However, the majority of building components are original (e.g., ceiling tiles, floors, univents, windows).

In October of 2004, the TSD contracted with Environmental Enterprises & Associates, Inc. (EEI), an environmental consultant, to conduct IAQ testing and mold sampling. The EEI report recommended the following remediation activities in all areas where elevated mold levels were found: (1) vacuum all carpets with a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner; (2) clean and disinfect all surfaces with a broad based fungicide; (3) remove all water damaged ceiling tiles (throughout the building); (4) clean and disinfect all caulking with visible mold with a broad based fungicide, with plans to remove and replace this caulking; (5) disinfect the entire crawlspace with a broad based fungicide and (6) prevent water intrusion in the crawlspace to prevent further mold growth (EEI, 2004a).

EEI returned to the PES to perform post mold-remediation sampling and conduct further IAQ tests on December 2, 2004. The follow-up EEI report recommended further cleaning and disinfection be conducted in classroom 1, due to the detection of trace levels of a specific mold, *Aspergillus fumigatus*. According to EEI, all other areas were found to have mold counts lower than ambient concentrations (EEI, 2004b).

Methods

MDPH staff performed a visual inspection of building materials for water damage and/or microbial growth. Air tests for carbon monoxide, carbon dioxide, temperature and relative humidity were conducted with the TSI, Q-Trak, IAQ Monitor, Model 8551. Air tests for airborne particle matter with a diameter less than 2.5 micrometers were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. Screening for total volatile organic compounds (TVOCs) was conducted using a Thermo Environmental Instruments Inc., Model 580 Series Photo Ionization Detector (PID).

Results

The PES houses approximately 390 first through fourth grade students and 60 staff members. Tests were taken during normal operations at the school and results appear in Table 1.

Discussion

Ventilation

It can be seen from Table 1 that carbon dioxide levels were elevated above 800 parts per million (ppm) of air in twenty-one of twenty-nine areas surveyed, indicating inadequate ventilation in the majority of areas surveyed. Several of the rooms with carbon dioxide levels below 800 ppm were unoccupied or sparsely populated, which can greatly reduce carbon dioxide levels. It is also important to note however, that the assessment occurred on an extremely cold day (20^{o} F), during which outside air intake is limited in order to prevent freezing of pipes.

Fresh air in classrooms is supplied by a unit ventilator (univent) system (Pictures 1 and 2). Univents draw air from outdoors through fresh air intakes located on the exterior walls of the building (Picture 3) and return air through air intakes located at the base of each unit (Figure 1). Fresh and return air are mixed, filtered, heated and/or cooled and provided to classrooms through a diffuser located on the top of the unit. Adjustable louvers control the ratio of fresh and recirculated air. As discussed, during extremely cold temperatures, outside air intake is limited to prevent freezing of pipes. The majority of univents were operating during the assessment; however, some univents had been deactivated (Table 1). Obstructions to airflow, such as furniture located in front of univent return vents, were observed in some classrooms. In order for univents to provide fresh air as designed, these units must remain activated and allowed to operate free from obstructions.

Exhaust ventilation in classrooms is provided by ducted, grated wall vents powered by rooftop motors. All of the exhaust vents were operating during the assessment, with one exception. The vent in classroom 20 was not drawing air, indicating that motors were either deactivated or non-functional. A number of exhaust vents were also obstructed by desks, bookcases and other items (Picture 4). As with the univents, in order to function properly, exhaust vents must be activated and remain free of obstructions. In addition, the location of exhaust vents can limit exhaust efficiency. In some classrooms, exhaust vents are near hallway doors (Picture 5). When classroom doors are open, exhaust vents will tend to draw air from both the hallway and the classroom. The open hallway door reduces the effectiveness of the exhaust vent to remove common environmental pollutants from classrooms.

Classroom 17 has been divided in half to make two separate rooms, 17 and 17 G. Dividing the room placed the univent in one room (17 G) and the exhaust vent in the other (17). In order to provide air exchange/cross ventilation, a passive vent should be installed in the wall separating the two rooms.

Ventilation for modular classrooms is provided by AHUs. Fresh air is distributed to classrooms via ductwork connected to ceiling-mounted air diffusers and drawn back to the AHUs through floor grilles (Picture 6). Thermostats control each heating, ventilating and air conditioning (HVAC) system and have fan settings of “on” and “automatic”. Thermostats were set to the “automatic” setting (Picture 7) during the assessment. The automatic setting on the thermostat activates the HVAC system at a preset temperature. Once the preset temperature is reached, the HVAC system is deactivated. Therefore, no mechanical ventilation is provided until the thermostat re-activates the system.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room, while removing stale air from the room. It is recommended that existing ventilation systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires that each room have a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health

Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, see Appendix A.

Temperature measurements ranged from 67^{o} F to 79^{o} F, which were slightly below the MDPH recommended comfort range in some areas and slightly above in others. The MDPH recommends that indoor air temperatures be maintained in a range of 70^{o}F to 78^{o}F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. A number of temperature control complaints were reported during the assessment. The building is reported to have chronic issues with temperature control, despite efforts from the TSD to calibrate thermostats and make repairs to heating/ventilation equipment over the years. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building ranged from 22 to 30 percent, which was below the MDPH recommended comfort range. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States. In contrast, relative humidity in excess of 70 percent for extended periods of time can provide an environment for mold and fungal growth (ASHRAE, 1989), which is explained in further detail below.

Microbial/Moisture Concerns

In the experience of MDPH staff, excessively humid weather can provide enough airborne water vapor to create adequate conditions for mold growth in buildings. In general, materials that are prone to mold growth can become colonized when moistened for more than 24 hours. Since hot, humid weather persisted in Massachusetts for more than 14 days during the month of August, 2003 (The Weather Underground, 2003), materials in a large number of schools and buildings were moistened for an extended period of time. As a result, mold growth occurred in moistened materials.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

As reported by the TSD and PES staff, a number of materials were either colonized with mold or in contact with mold spores. At the time of the CEH assessment materials in the building that were colonized with mold had either been removed or disinfected. CEH staff did, however, observe visible mold growth in classroom 9. However, this mold growth appeared to be from water damage caused by the use of a small refrigerator placed on a wooden tabletop (Picture 8). This type of equipment generates condensation.

Occupants also expressed concern regarding the presence of mold growth on the surface of corkboards, which are used extensively in a number of applications, including cabinet doors for classroom univents throughout the building (Picture 1). During the initial walkthrough on January 20, 2005, CEH staff recommended the removal of corkboards located directly above sinks. These were removed prior to the February 3, 2005 follow-up visit. In several cases, corkboards appeared to have surface staining, but did not appear to have active mold growth.

Active roof leaks were reported in a number of areas. Picture 9 illustrates an attempt to drain the roof in an area of chronic water pooling. Mr. Sanborn reported that he planned to contract with a roofing firm to "build-up" this portion of the roof to prevent pooling. Several classrooms ceiling tiles that appeared bowing and disintegrating due to stress (Picture 10). Similar observations were seen in tiles along the roof eaves. These tiles also appeared to have significant damage (Picture 11), and spaces from bowing tiles can provide a means of water penetration into the building. In several cases, these tiles had been removed and replaced with plywood (Picture 12).

Another potential pathway for moisture to enter into the building includes open holes/damage to exterior walls (Pictures 13 and 14). These breaches to the building envelope can allow water to penetrate the building. Repeated water penetration can result in the chronic wetting of building materials and potential microbial growth. In addition, these holes may provide a means of egress for pests/rodents into the building.

In several areas around the building, small trees/stumps and other plants were observed growing against the foundation. Clinging plants were noted on exterior walls (Pictures 3 and 15). The growth of plants/roots against the exterior walls and along the foundation can bring moisture in contact with wall brick, eventually lead to cracks and/or fissures in the foundation below ground level. Clinging plants can cause water damage to brickwork, since the plants insert tendrils into brick and mortar. Water can penetrate into the brick/concrete along the tendrils. Subsequently freezing/thawing in the winter action can weaken building materials, resulting in wall damage. In addition, plant growth in close proximity to univent air intakes can draw in allergens such as mold and pollen.

A number of areas had loose or broken windowpanes through which drafts could be felt (Pictures 16 and 17). These conditions indicate that the window’s water seal is no longer intact. Under certain conditions, water penetration through window frames can lead to water damage and/or potential mold growth. Another possible source for mold growth is the storage of porous items beneath classroom sinks; these areas tend to be moist environments due to plumbing fixtures. In classrooms throughout the school, items such as newspapers, magazines and cardboard were stored in these cabinets; some of the paper goods appeared to have been water damaged.

Several classrooms contained a number of plants. Plants, soil and drip pans can serve as sources of mold growth, and thus should be properly maintained. Plants should have drip pans to prevent wetting and subsequent mold colonization of window frames. Plants should also be located away from univents and ventilation sources to prevent aerosolization of dirt, pollen or mold.

Lastly, MDPH staff observed conditions in the crawlspace. Several inches of water was observed, however, the water appeared clean and no stagnant odors were detected. Mr. Sanborn reported that the crawlspace was mechanically depressurized to prevent the potential migration of odors into occupied areas. Although the local exhaust fans could not be located by MDPH staff, a tremendous amount of airflow was evident.

Other Concerns

Indoor air quality can be adversely impacted by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion products include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers (μm) or less (PM2.5) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the school environment, MDPH staff obtained measurements for carbon monoxide and PM2.5.

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide pollution and prevent symptoms from exposure to these substances. The MDPH established a corrective action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

ASHRAE has adopted the National Ambient-Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from 6 criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2000a). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS established by the US EPA, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2000a).

Carbon monoxide should not be present in a typical, indoor environment. If it *is* present, indoor carbon monoxide levels should be less than or equal to outdoor levels. Outdoor carbon monoxide concentrations were non-detect or ND (Table 1). Carbon monoxide levels measured in the school were also ND.

Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The NAAQS originally established exposure limits for particulate matter with a diameter of 10 μm or less (PM10). According to the NAAQS, PM10 levels should not exceed 150 micrograms per cubic meter ($\mu g/m^3$) in a 24-hour average (US EPA, 2000a). This standard was adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, US EPA proposed a more protective standard for fine airborne particles. This more stringent, PM2.5 standard requires outdoor air particulate levels be maintained below 65 $\mu g/m^3$ over a 24-hour average (US EPA, 2000a). Although both the ASHRAE standard and BOCA Code adopted the PM10 standard for evaluating air quality, MDPH uses the more protective proposed PM2.5 standard for evaluating airborne particulate matter concentrations in the indoor environment.

Outdoor PM2.5 concentrations were measured at 30 $\mu g/m^3$ (Table 1). PM2.5 levels measured indoors ranged from 15 to 29 $\mu g/m^3$, which were below background as well as the NAAQS of 65 $\mu g/m^3$. Frequently, indoor air levels of particulates (including PM2.5) can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur in schools can generate particulates during normal operations. Sources of indoor airborne particulates may include but are not limited to particles generated during the operation of fan belts in the HVAC system; cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices; operation of an ordinary vacuum cleaner and heavy foot traffic indoors.

Indoor air quality can also be impacted by the presence of materials containing volatile organic compounds (VOCs). VOCs are substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. For example, chemicals evaporating from a paint can stored at room temperature would most likely contain VOCs. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted. Outdoor air samples were taken for comparison. Outdoor TVOC concentrations were ND (Table 1). Indoor TVOC measurements throughout the building were also ND.

Please note, TVOC air measurements are only reflective of the indoor air concentrations present at the time of sampling. Indoor air concentrations can be greatly impacted by the use of TVOC containing products. While no measure able TVOC levels were detected in the indoor environment, VOC-containing materials were noted. Cleaning products, spray paint aerosol cans and unlabeled spray bottles were found on countertops and/or beneath sinks in a number of classrooms. These materials contain VOCs and other chemicals, which can be irritating to the eyes, nose and throat and should be stored properly and kept out of reach of students. Spray bottles should also be properly labeled in the event of an emergency. In one classroom, a restricted use pesticide was found in an unlocked cabinet below the sink (Picture 18). Under current Massachusetts law (effective November 1, 2001), the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals that can be sources of eye, nose and throat irritation. In addition pesticides can only be applied by a licensed pest applicator.

Several classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain VOCs, such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999), which can be irritating to the eyes, nose and throat.

In an effort to reduce noise from sliding chairs, tennis balls had been sliced open and placed on chair legs. Tennis balls are made of a number of materials that are a source of respiratory irritants. Constant wearing of tennis balls can produce fibers and cause TVOCs to off-gas. Tennis balls are made with a natural rubber latex bladder, which becomes abraded when used as a chair leg pad. Use of tennis balls in this manner may introduce latex dust into the school environment. Some individuals are highly allergic to latex (e.g., spina bifida patients) (SBAA, 2001). It is recommended that the use of materials containing latex be limited in buildings to reduce the likelihood of symptoms in sensitive individuals (NIOSH, 1997). A question and answer sheet concerning latex allergy is attached as Appendix B (NIOSH, 1998).

Several other conditions that can affect indoor air quality were seen during the assessment. Accumulated chalk dust in chalk trays was seen in several classrooms. Chalk dust is a fine particulate, which can become easily aerosolized and serve as a source of eye and respiratory irritation. Exposed fiberglass insulation was noted around pipes in classrooms (Pictures 19 and 20). In several areas, plywood was installed to prevent exposure (Picture 21). Fiberglass insulation can be a source of skin, eye and respiratory irritation to sensitive individuals.

Fuel/boiler room odors were detected in the hallway between the boiler room and the cafeteria. The boiler room door was found pegged open, allowing odors to migrate into adjacent areas (Picture 22). The door also did not have a means to close properly because the doorknob had been removed (Picture 23).

Lastly, of note is the amount of materials stored inside classrooms. In a number of areas, items were observed on windowsills, tabletops, counters, bookcases and desks.

The large number of items stored in classrooms provides a source for dusts to accumulate. These items (e.g., papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to the eyes, nose and respiratory tract. For this reason, items should be relocated and/or cleaned periodically to avoid excessive dust build up.

Conclusions/Recommendations

The conditions noted at the PES raise a number of indoor air quality issues. The general building conditions, excessive outdoor humidity over the summer, maintenance, work hygiene practices and the age/condition of HVAC equipment, if considered individually, present conditions that could degrade indoor air quality. When combined, these conditions can serve to further degrade indoor air quality. Some of these conditions can be remedied by actions of building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons, a two-phase approach is required for remediation. The first consists of **short-term** measures to improve air quality and the second consists of **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

In view of the findings at the time of the visit, the following **short-term** recommendations are made:

1. Continue to work with concerned individuals to identify and address IAQ/mold concerns. Should mold issues recur, remove mold-contaminated materials in a manner consistent with recommendations found in "Mold Remediation in Schools and Commercial Buildings" published by the US EPA (US EPA, 2001). Copies

of this document can be downloaded from the US EPA website at: http://www.epa.gov/iaq/molds/mold_remediation.html.

2. Clean the surface of corkboards using a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner vacuum equipped with a brush attachment if mold growth reoccurs on. If mold growth has *colonized* the corkboard or if growth occurs *repeatedly*, removal or replacement should be considered.
3. Continue with plans to make roof repairs to prevent water from pooling/ penetrating.
4. Repair/replace severely water-damaged ceiling tiles/panels in classroom 3 and around the perimeter of the building. Consider temporarily replacing with plywood as shown in Picture 12.
5. Contact a masonry firm or general contractor to repair holes/breaches in exterior walls to prevent water penetration, drafts and pest entry.
6. Operate all ventilation systems throughout the building (e.g., gym, auditorium, classrooms) continuously during periods of school occupancy independent of thermostat control to maximize air exchange. To increase airflow in classrooms, set univent controls to "high".
7. Use openable windows in conjunction with classroom univents and exhaust vents to increase air exchange. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding.
8. Continue with plans to repair rooftop exhaust motors.

9. Remove all blockages from univents and exhaust vents. Close classroom doors to facilitate air exchange.
10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Avoid the use of feather dusters. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
11. Repair/replace broken windows; re-seal loose window frames to prevent drafts and water penetration.
12. Ensure all plants are equipped with drip pans. Examine drip pans for mold growth and disinfect areas of water leaks with an appropriate antimicrobial where necessary. Move plants away from ventilation sources in classrooms.
13. Refrain from storing porous items (e.g., paper, cardboard) beneath classroom sinks to prevent mold growth.
14. Store cleaning products properly and out of reach of students.
15. Conduct a thorough inventory to ensure pesticides are removed from classrooms. Use the principles of integrated pest management (IPM) to rid the building of pests. A copy of the IPM recommendations can be obtained from the Massachusetts Department of Food and Agriculture (MDFA) website at the

following website:

http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf.

16. Relocate or consider reducing the amount of materials stored in classrooms to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
17. Clean univent air diffusers and exhaust vents periodically of accumulated dust.
18. Consider developing a written notification system for building occupants to report indoor air quality issues/problems. Have these concerns relayed to the maintenance department/ building management in a manner that allows for a timely remediation of the problem. An example is included as Appendix C.
19. Consider adopting the US EPA (2001) document, "Tools for Schools" to maintain a good indoor air quality environment on the building. This document can be downloaded from the Internet at http://www.epa.gov/iaq/schools/index.html.
20. Refer to resource manuals and other related indoor air quality documents for information on building-wide evaluations and advice on maintaining public buildings. These documents are available on the MDPH's website: http://www.state.ma.us/dph/MDPH/iaq/iaqhome.htm.

At the time of the assessment, replacement of the PES was being proposed by the City of Taunton. In the event that these plans do not progress, the following **long-term** recommendations are made.

1. Consider having exterior walls re-pointed and waterproofed to prevent water. intrusion. This measure should include a full building envelope evaluation.

2. Consider total roof replacement including the removal of historical "patches".
3. Examine the feasibility of enhancing drainage to areas of the roof subject to water pooling. This may include redirecting the pitch of the roof towards drains or installation of new drains.
4. Consider total removal/replacement of ceiling tile system.
5. Repair/replace loose/broken windowpanes and missing or damaged window caulking building-wide to prevent water penetration through window frames.
6. Contact an HVAC engineering firm for a full evaluation of the ventilation system. Considering the age, physical deterioration and availability of parts of the HVAC system, an evaluation is strongly recommended for proper operation and/or repair/replacement of the ventilation system.
7. Repair and/or replace thermostats and pneumatic controls as necessary to maintain control of thermal comfort. Consider contacting an HVAC engineer concerning the condition and calibration of thermostats and pneumatic controls school-wide.

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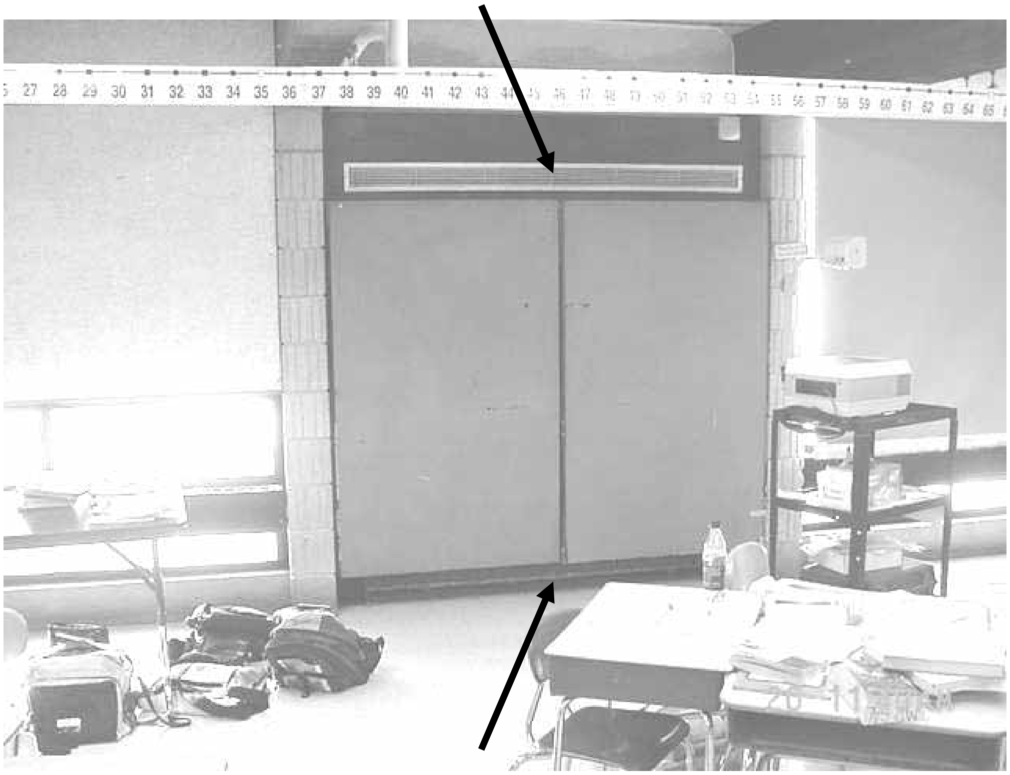
Picture 1



Classroom Univent, Note Corkboard Cabinet Doors

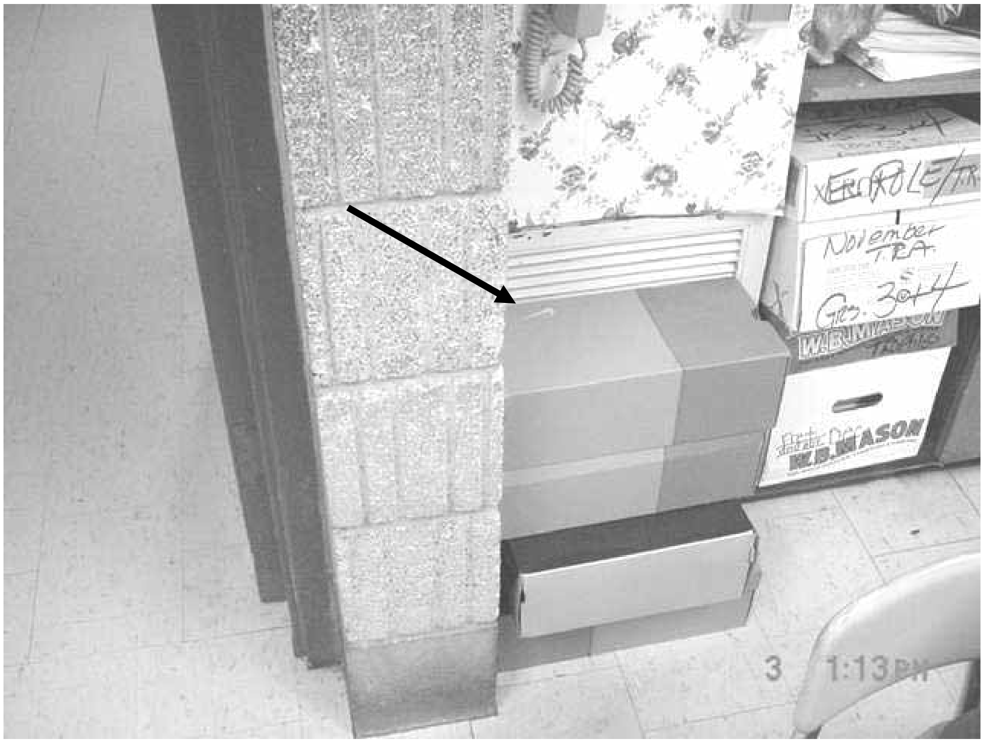
Picture 2

Classroom Univent With Cabinet Doors Opened

Picture 3

Univent Fresh Air Intake, Note Plant Growth in and around Vent

Picture 4



Classroom Exhaust Vent Obstructed by Boxes

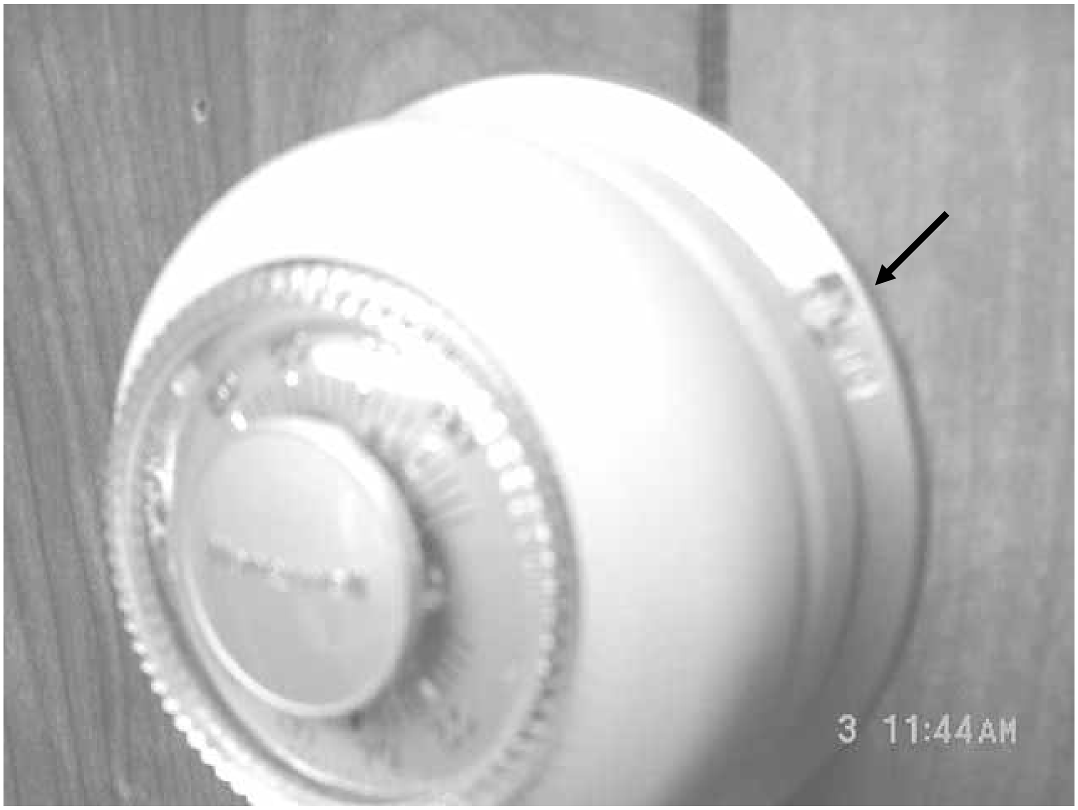
Picture 5

Classroom Exhaust Vent and Open Hallway Door

Picture 6

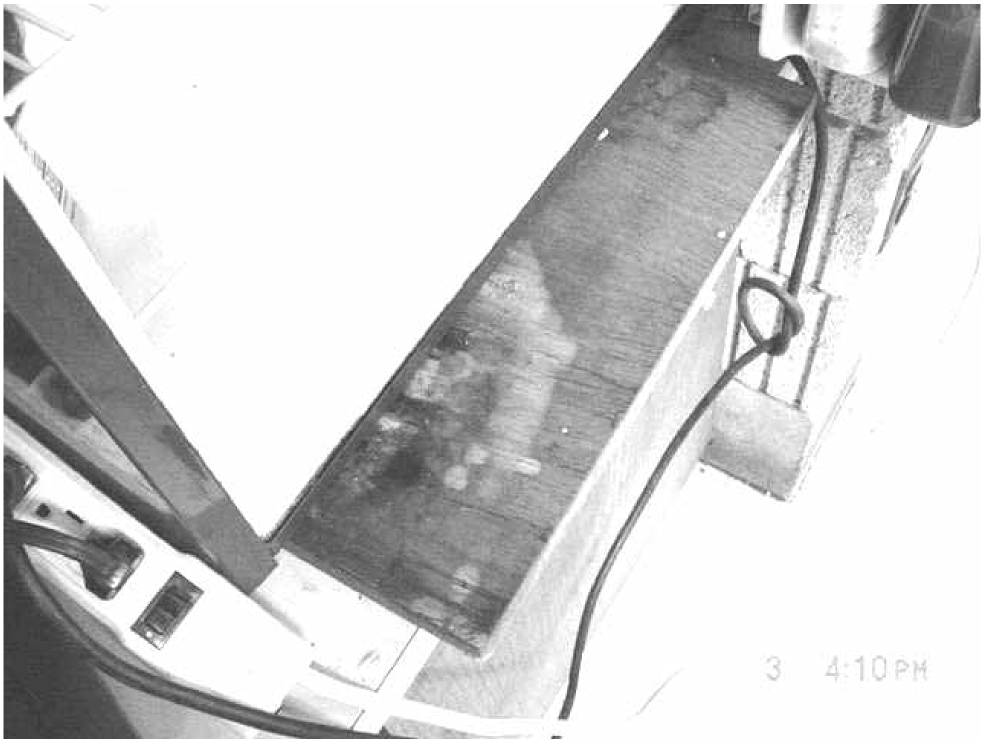
Floor Vent in Modular Classroom

Picture 7



Modular Classroom Thermostat in the Fan "Auto" Setting

Picture 8

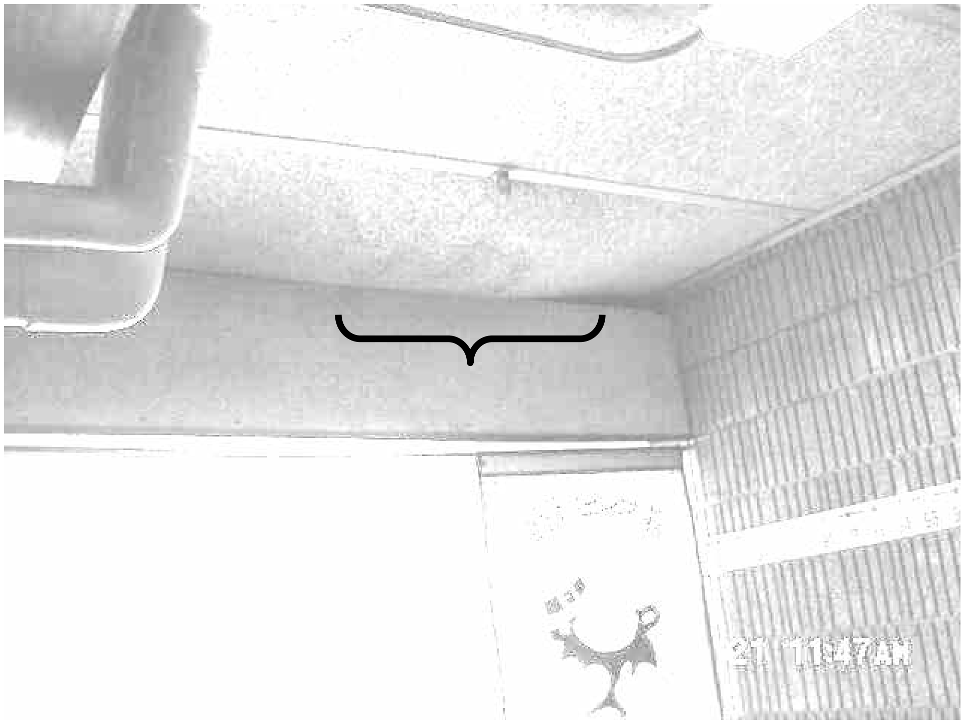


Mold-Colonized Wooden Table beneath Refrigerator in Classroom 9

Picture 9

Drainage to Help Prevent Water Penetration in Main Hallway

Picture 10



Water Damaged "Bowing" Ceiling Tile in Classroom 3

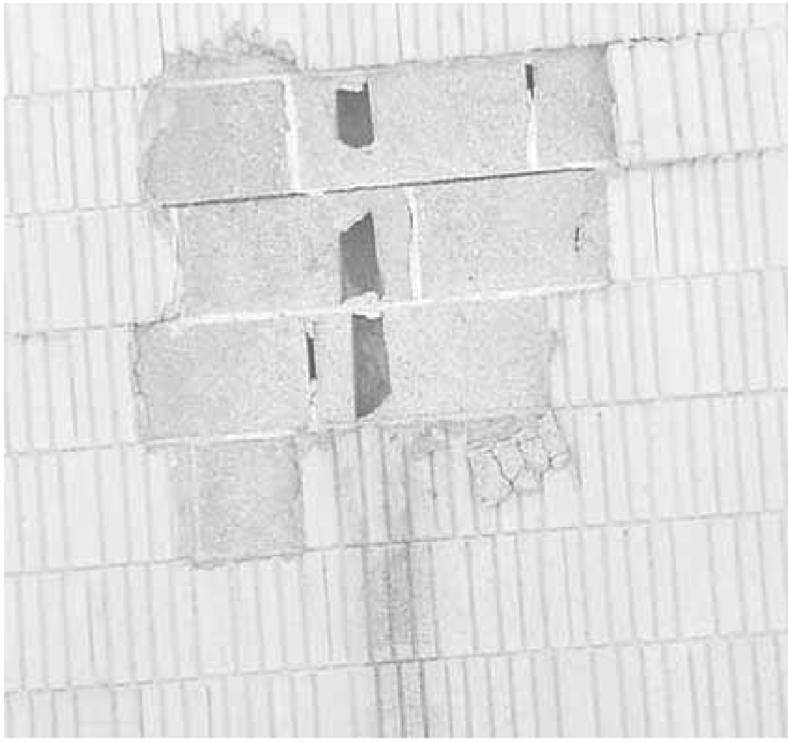
Picture 11

Severely Damaged Ceiling Panel on Exterior of Building

Picture 12

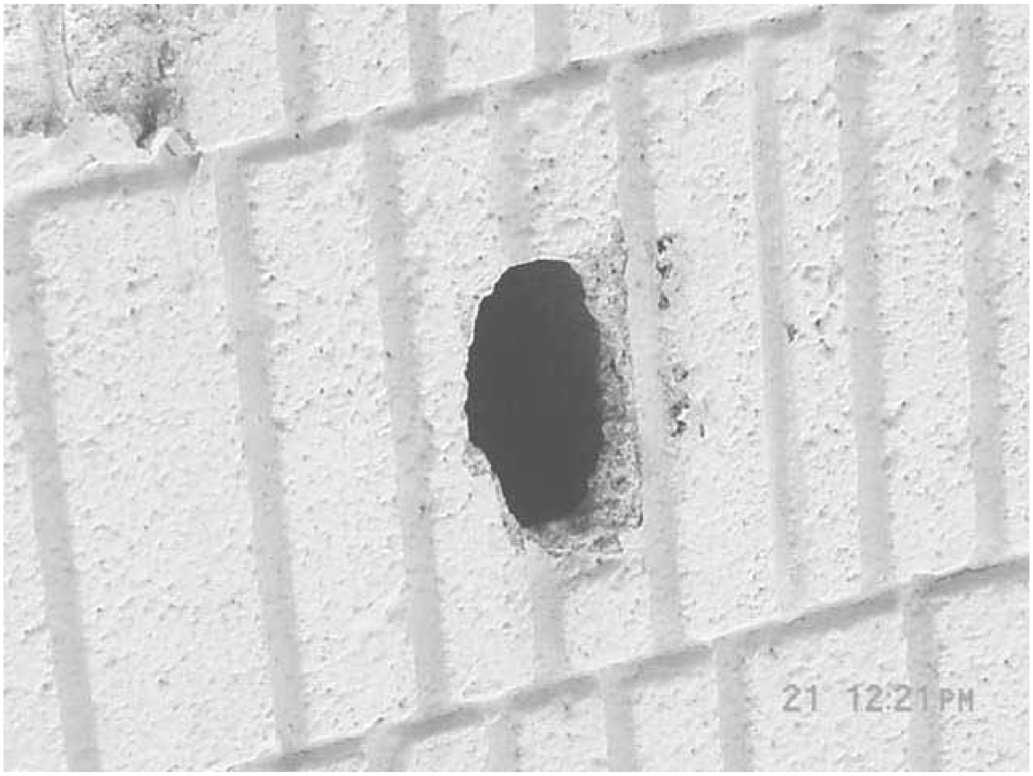
Ceiling Panel Replaced With Plywood

Picture 13



Missing/Damaged Exterior Wall Brick

Picture 14



Large Hole in Exterior Wall

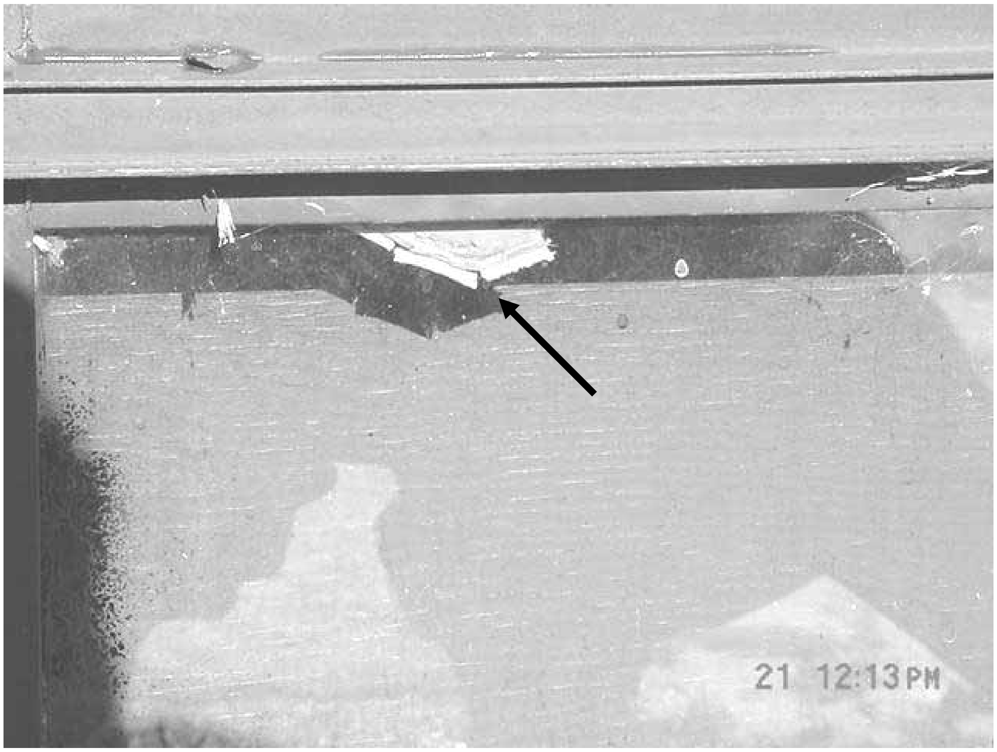
Picture 15

Tree Stump Growing Against Foundation/Exterior Wall

Picture 16

Broken Windowpane

Picture 17

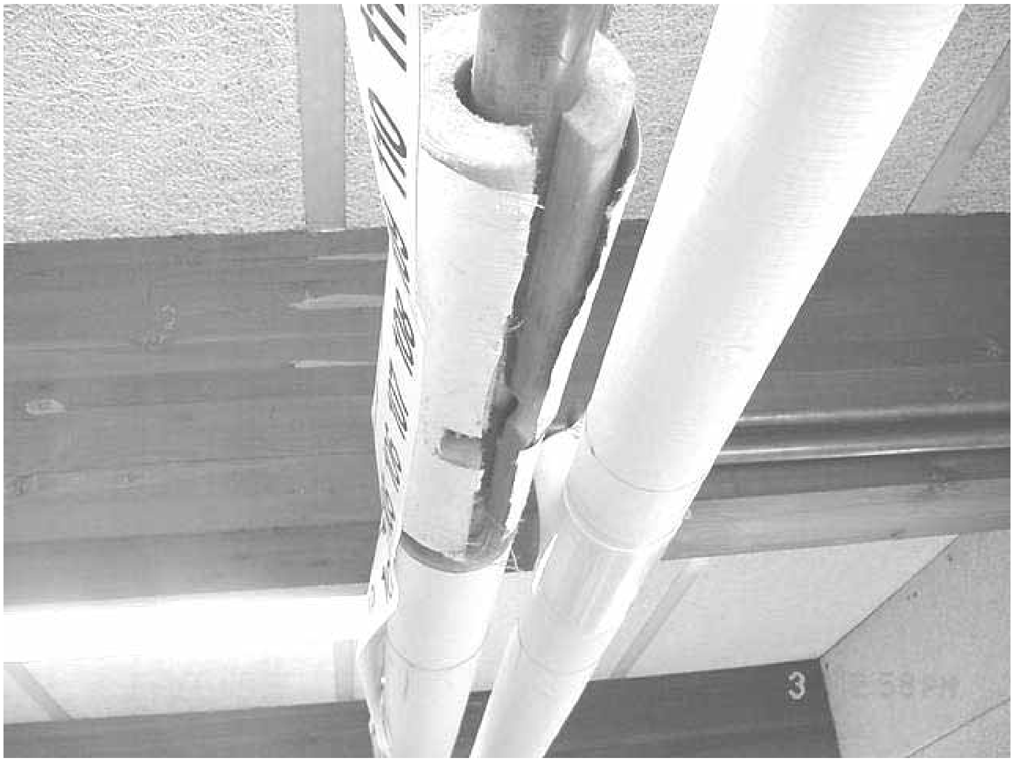


Failing Caulking around Windowpane

Picture 18

Aerosol Cans of Pesticide, Furniture Polish, All Purpose Cleaner and an Unlabeled Spray Bottle beneath Classroom Sink in Unlocked Cabinet

Picture 19



Exposed Fiberglass Pipe Wrap in Classroom

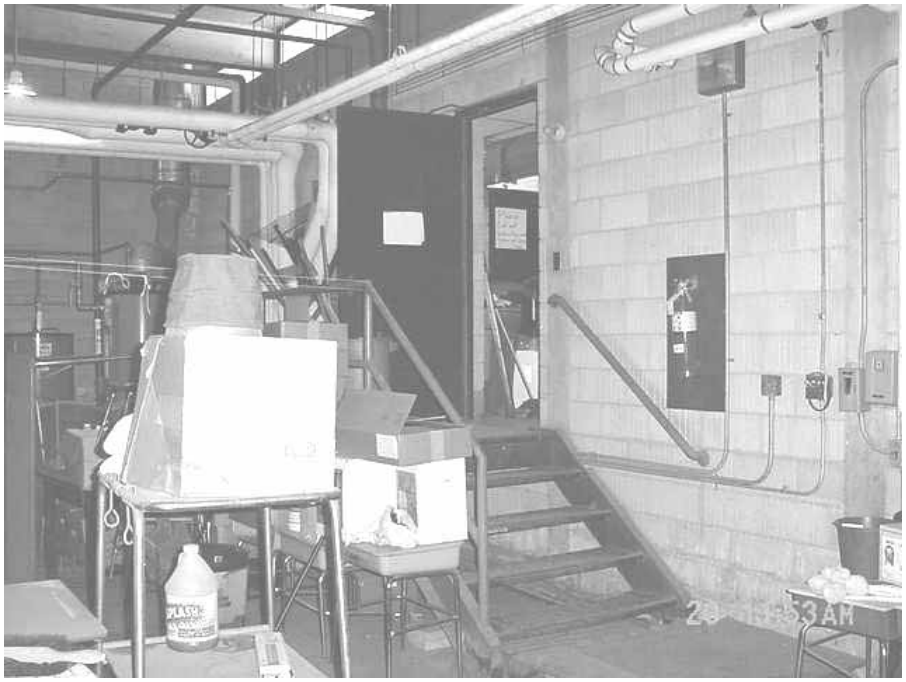
Picture 20

Exposed Fiberglass Insulation in Classroom

Picture 21

Plywood Installed over Fiberglass Insulation

Picture 22



Boiler Room Door Propped Open

Picture 23

Boiler Room Door Note Doorknob is Removed

Elizabeth Pole School

110 County Street, Taunton, MA 02780

Table 1

Indoor Air Results

Date: 02/03/2005

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background	ND	20	31	373	ND	ND	30	N # open: 0 # total: 0			Comments: cold, overcast.
10	22	67	30	858	ND	ND	21	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; water damaged ceiling and other materials, DEM, cleaners, clutter, dehumidifier, Comments: periodic roof leaks, efflorescence corner/walls, water damaged materials under sink, spray paint.
9	12	70	25	944	ND	ND	29	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; PF, clutter.

ppm = parts per million
µg/m3 = micrograms per cubic meter

AD = air deodorizer
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aqua. = aquarium
AT = ajar ceiling tile
BD = backdraft
CD = chalk dust
CP = ceiling plaster
CT = ceiling tile
DEM = dry erase materials
design = proximity to door
FC = food container
G = gravity
GW = gypsum wallboard
M = mechanical
MT = missing ceiling tile
NC = non-carpeted
ND = non detect
PC = photocopier
PF = personal fan
plug-in = plug-in air freshener
PS = pencil shavings
sci. chem. = science chemicals
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VL = vent location
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Comfort Guidelines

Carbon Dioxide: < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F
Relative Humidity: 40 - 60%

Elizabeth Pole School

110 County Street, Taunton, MA 02780

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Indoor Air Results

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
6	22	71	25	1134	ND	ND	22	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; DEM, clutter.
5	19	71	25	979	ND	ND	19	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; DEM.
2	25	70	26	1090	ND	ND	15	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; DEM.
1	19	71	26	989	ND	ND	18	Y # open: 0 # total: 3	Y univent wall		Hallway door open; DEM, cleaners.

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Elizabeth Pole School **Indoor Air Results**

110 County Street, Taunton, MA 02780 **Date: 02/03/2005**

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									Supply	Exhaust	
Portable Classrooms	ND	69	24	561	ND	ND	15	Y # open: 0 # total: 6	Y floor	Y floor	DEM, cleaners, temperature complaints (cold), temperature complaints (hot), Comments: Thermostat fan set to "auto".
3	21	70	30	826	ND	ND	20	Y # open: 1 # total: 3	Y univent wall	Y wall	Hallway door open; water damaged ceiling, #water damaged CT: 1, DEM, Comments: bowing/water damaged CT in corner.
4	25	74	23	1020	ND	ND	17	Y # open: 0 # total: 0	Y univent wall	Y wall	Hallway door open; window, Comments: broken window pane.
7	17	79	24	890	ND	ND	24	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; DEM, Comments: concerns of stained corkboard.

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									Supply	Exhaust	
Art	ND	74	22	630	ND	ND	19	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open
Gym	21	74	25	942	ND	ND	20	N # open: 0 # total: 0	Y wall	Y wall	Hallway door open; Exhaust blocked by boxes and clutter, Comments: recommend checking air intake for AHUs.
Boiler Room	ND	ND	ND	ND	ND	ND	ND	N # open: 0 # total: 0			Comments: Door propped open, odors in Hallway door open; no doorknob.
Teacher's Lounge	ND	73	24	708	ND	ND	16	Y # open: 1 # total: 1	N	N	Cleaners, Comments: exposed fiberglass insulation walls/pipes.

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									Supply	Exhaust	
Cafeteria	100	73	29	758	ND	ND	19	N # open: 0 # total: 0	Y wall	Y wall	Hallway door open;
15	22	71	29	1323	ND	ND	21	Y # open: 0 # total: 3	Y wall	Y wall	Hallway door open; exhaust blocked by boxes, DEM, clutter.
14	22	71	28	1169	ND	ND	25	Y # open: 0 # total: 3	Y wall	Y wall	DEM, cleaners, clutter, plants.
19	34	74	27	1280	ND	ND	21	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; Supply blocked by furniture, exhaust blocked by clutter, AP, DEM, TB, Comments: exposed fiberglass-pipes.

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Elizabeth Pole School **Indoor Air Results**

110 County Street, Taunton, MA 02780 **Table 1** **Date: 02/03/2005**

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									Supply	Exhaust	
18	21	72	24	1306	ND	ND	18	N # open: 0 # total: 0	Y univent wall	Y wall	
11	16	74	30	1071	ND	ND	24	Y # open: 0 # total: 3	Y univent wall	Y wall	Hallway door open; DEM.
12	21	74	30	1072	ND	ND	21	Y # open: 0 # total: 3	Y wall	Y wall	Hallway door open; DEM, cleaners, Comments: water damaged materials under sink.
13	21	74	26	1337	ND	ND	20	Y # open: 0 # total: 3	Y wall	Y wall	Hallway door open; water damaged ceiling, DEM, TB, plants.
16	33	70	30	1237	ND	ND	24	Y # open: 1 # total: 3	Y univent wall	Y wall	DEM, TB.

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									Supply	Exhaust	
17	1	70	27	762	ND	ND	19	N # open: 0 # total: 0	N	Y wall	Inter-room door open
17 G	5	70	28	669	ND	ND	19	Y # open: 0 # total: 3	Y univent wall	N	Inter-room, TB, Comments: recommend passive vent between rooms.
Library	30	69	29	786	ND	ND	19	N # open: 0 # total: 0	N	N	Water damaged ceiling, Comments: central location/open floor plan.
20 A	ND	71	26	807	ND	ND	17	Y # open: 0 # total: 1	Y univent wall	N	Hallway door open; DEM.
20	ND	71	25	620	ND	ND	16	Y # open: 0 # total: 1	Y univent wall (off)	Y wall (off)	Hallway door open; DEM.

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									Supply	Exhaust	
Nurse	1	71	26	887	ND	ND	17	N # open: 0 # total: 0	N	Y	Hallway door open
Main Office	1	70	26	910	ND	ND	20	N # open: 0 # total: 0	N	Y wall	Hallway door open

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BEDFORD PUBLIC SCHOOLS

TOWN OF BEDFORD

WORK ORDER

REPAIR # ________

DATE: __________ TIME: ____________

☐ ROUTINE
☐ EMERGENCY
☐ VIOLATION
☐ PROJECT

REQUESTED BY: ext.

APPROVED BY: ext.

SCHOOL/BUILDING

MACHINE #

Room #

DESCRIPTION OF PROBLEM:

LIST BELOW ACTUAL WORK DONE:	DONE BY: DATE:	INITIALS	WORK TIME: HRS.	MIN.

NOTES:

CREW ASSIGNMENTS:
☐ 00. MAINT. TECH.
☐ 01. HVAC TECH
☐ 02. CARPENTER
☐ 03. ELECTRICIAN
☐ 04. PLUMBER
☐ 05. PAINTER
☐ 06. CUSTODIAN
☐ 07. SUPERVISOR
☐ 08. DRIVER
☐ 09. SECRETARY
☐ 10. OTHER

CAUSE:
☐ 0. PM DIRECTED
☐ 1. PREV. MAINT.
☐ 2. FAILURE
☐ 3. VANDALISM
☐ 4. PROJECT
☐ 5. SAFETY
☐ 6. TRAINING
☐ 7. ADMINISTRATION
☐ 8. TOILET/ DRAIN PROB
☐ 9. CIRCUIT BREAKER
☐ A. OTHER

MATERIALS

LINE	QUANTITY	DESCRIPTION	COST
		TOTAL:	

SUPERVISION USE ONLY

WAITING FOR PARTS	SCHEDULE
PURCH. ORDER #:	START:
DATE ORDERED:	COMPLETE:
DATE RECEIVED:	REVIEWED:

White - Facilities Dept./Yellow - Return to Issuer/Pink - School or Dept. Requesting